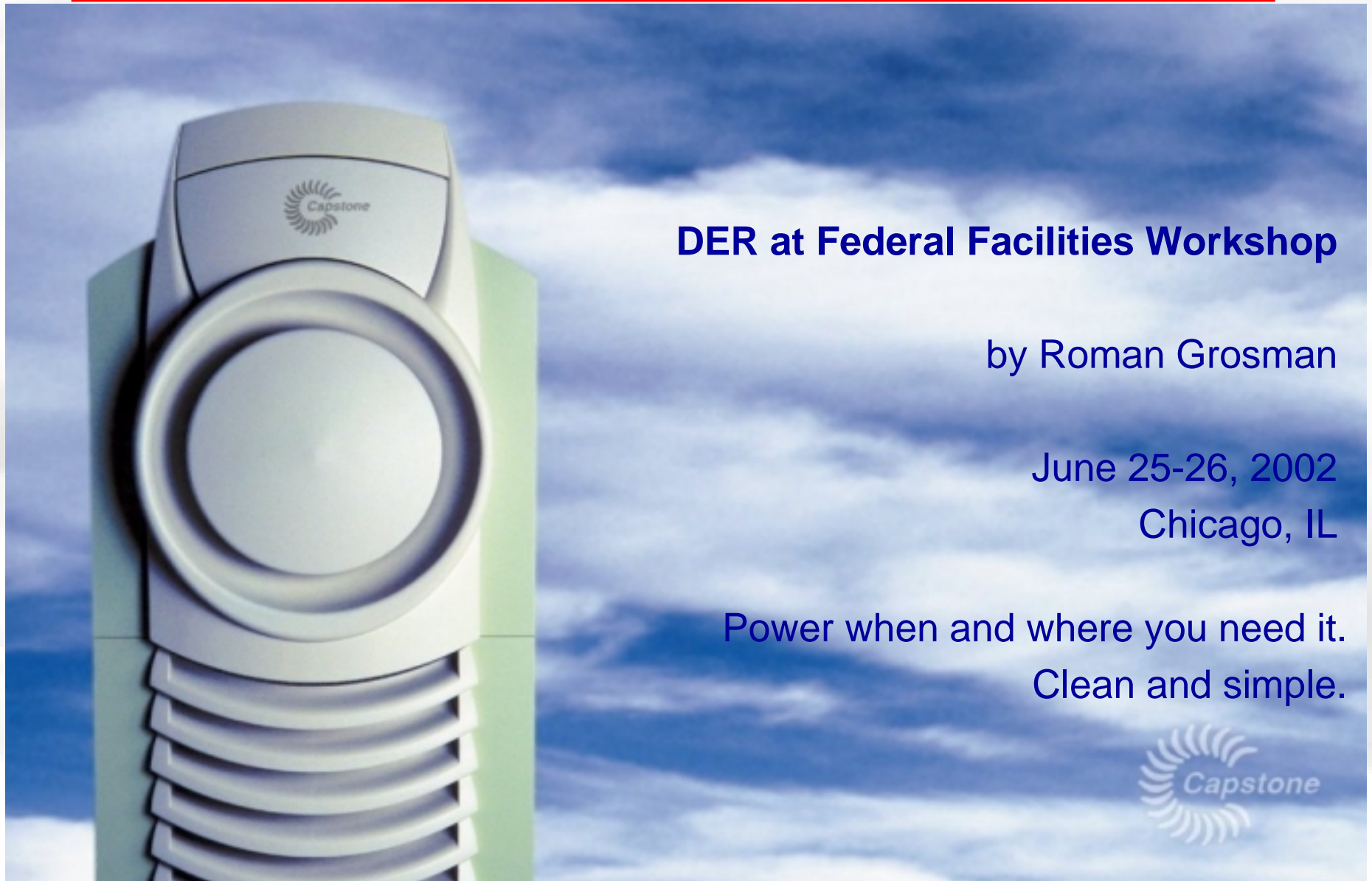




MICROTURBINE Case Study



DER at Federal Facilities Workshop

by Roman Grosman

June 25-26, 2002

Chicago, IL

Power when and where you need it.

Clean and simple.



Applications: Micro-Cogeneration (CHP)



**Brick Factory
Brick Drying
Starland, Holland**

**Boiler, Kitchen
Laundry, etc.
Holiday Inn
Fargo, ND**



**Boiler Water Preheating
Durham County Hall, UK**

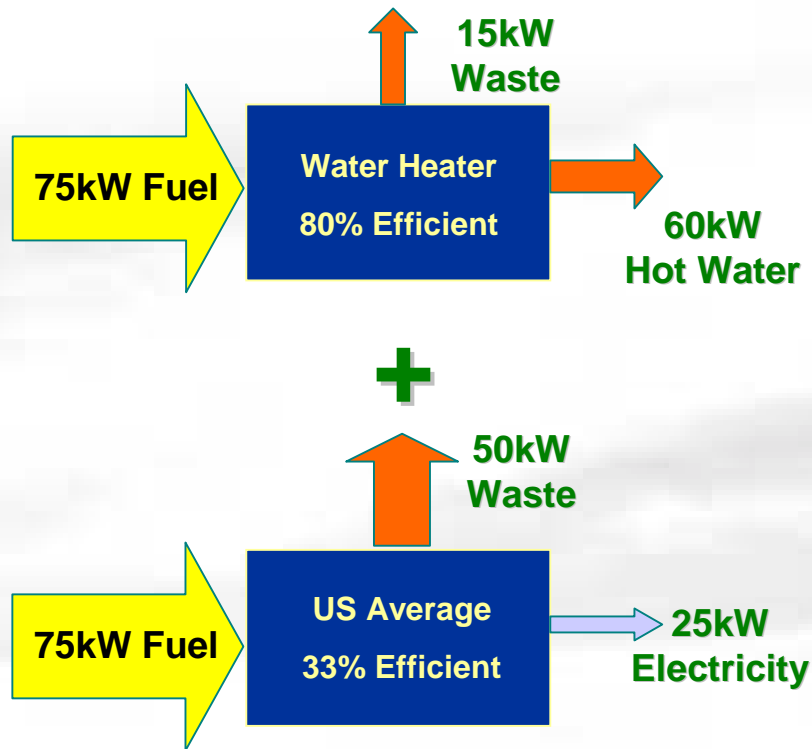
**Kobe, Japan
Mitsubishi CHP with
10-ton Yazaki
chillier**



Case Study: The Benefit of MicroCHP

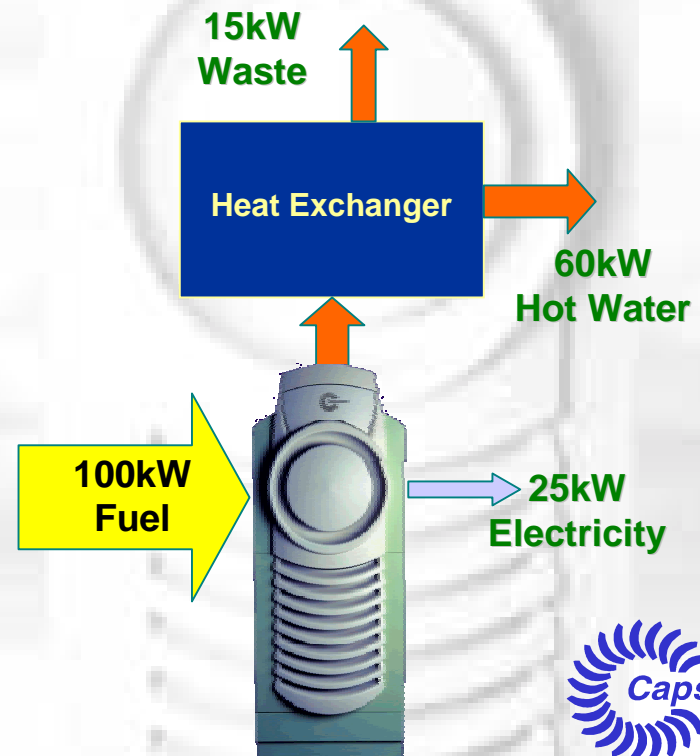
Traditional

- 57% Total Efficiency
- 0.1 lb/hr NO_x
- 60 lb/hr CO₂



MicroCHP

- 85% Total Efficiency
- 0.01 lb/hr NO_x
- 45 lb/hr CO₂



Micro-CHP Payback Example

Example CHP Systems with the following Characteristics:

60kW Rated Output

\$1,100 per kW System Cost

50kW Avg. Electrical Output

100kW Thermal Load

5,000 hr per year Operation

Electric Utility Rates:

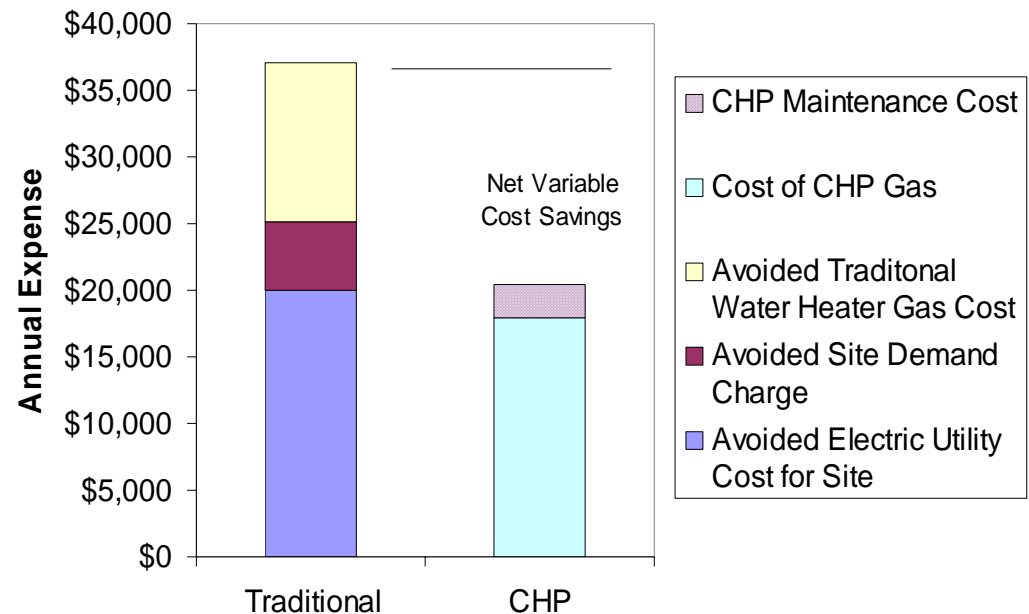
\$.08 per kWh

\$15 Demand

Gas Utility Rates:

\$5 per MM BTU

\$.01 per kWh Maintenance Cost



3 Year Simple Payback !!



A Real-World Industrial CHP Example



Combined Heat and Power (CHP)
for Primary Power and HVAC
in Manufacturing



Harbec Plastics Project: Summary

Reasons to seek CHP alternative

- High energy costs
 - #1 reason for businesses leaving New York State
 - Competing in world market means constant pursuit of cost effectiveness and competitive pricing.
- Need to improve electrical power reliability.
- Need to improve environmental control of manufacturing facility.
 - Consistent product quality year round.
- Desire to incorporate renewable energy potentials.

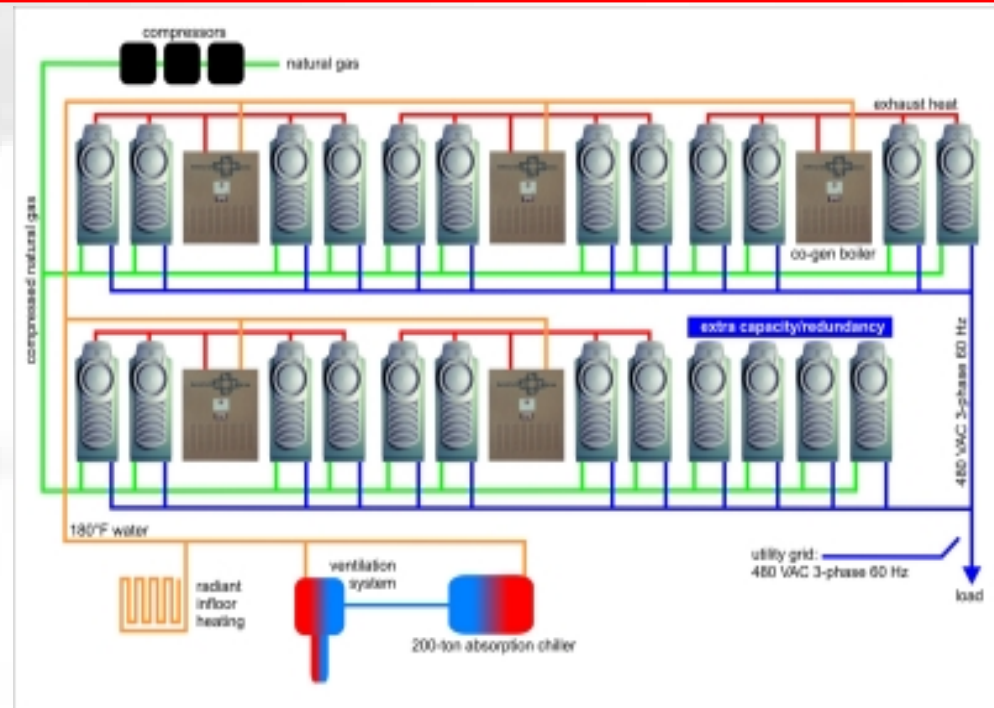
Actual deliverables

- Microturbines Selected as Engine Solution
 - Increased reliability
 - Decreased maintenance requirements
 - No increase in staff
 - More positive environmental impact - ISO 14001
 - ✓ Lower Emissions
 - ✓ No lubricants, filters, or coolants to deal with
- Implementation Requirements
 - Developed banking solution
 - Combined CHP plant with needed warehouse expansion



Harbec Plastics Project: CHP, Power Quality and Reliability

- **Applying proven technology**
 - Scalable with some level of redundancy
 - Efficient and economically feasible
 - Environmentally friendly



24-unit 700kW stand-alone MultiPac
system with heat recovery



Harbec Plastics Project: Uses for Waste Heat

Office HVAC in Summer



200 Ton Absorption Chiller
Converts 210° Hot Water to 44°-
47° Chilled Water

Warehouse Heating in Winter



Radiant Floor Heating
17,000' of 1" Diameter tubing



The Harbec CHP Project

Results

“Since July 9, 2001 microturbines have generated 100% of Harbec power requirements and have provided air conditioning and heat for an injection molding facility, while grid was maintained for back-up”

Economic

- Overall system efficiency > 70%
- Power from Utility = \$.105 / kWh
- Cost to Microturbine generate including maintenance= \$.07-.08 /kWh
- Thermal value added = \$.05-.06 /kWh
- Based on \$3.80 / decatherm - 2 year contract with TXU

Environmental

- Less consumption of fossil fuels by increasing efficiency
- CO₂ emissions reduced by >90%
- Significant reduction of SO_x and NO_x emissions
- No additional energy consumed to produce HVAC for plant.



Federal Facilities Using Capstone MicroTurbines

- ORNL, NREL, Sandia, UCI (DOE contract)
- Naval Amphibious Base, Coronado, CA
 - 2 C60 MicroTurbines with CHP
- Presidio Trust, San Francisco, CA
 - 2 C30 with CHP – boiler water pre-heating
 - PG&E low gas pressure
- TVA Public Power Institute, Muscle Shoals, AL
 - 1 C30 and 1 C60
- Fort Drum, NY
 - 1 C30 with CHP, hot water for barracks



Applications: Federal and Local Government



**South California
Prison**



**Denver, CO
Police Department**



**City Hall in California
Powered by wellhead
gas**



**Presidio Trust
Former Military Base
Now Public Park
California**



JUSTIFYING DER PROJECT

- 'Plain' economics
 - Cost of generated power
 - Reduced demand charges, etc.
- Take credit for
 - Avoided capital expense
 - Alternative generation means
- Assign dollar value to:
 - 'Political' benefits
 - Environmental concerns
 - Cost of potential down time, lost production
 - Security concerns
 - Impact on the community

Always look for combined benefits from multiple value streams
No single need will justify buying MicroTurbine

